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THE BLACK BOX CONUNDRUM OF NETWORK CENTRIC WARFARE

By

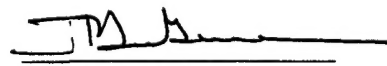
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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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The Black Box Conundrum of Network Centric Warfare

Abstract

The revolution occurring in the United States stock market has leveraged technological enhancements and brought about changes in the fundamental way business is conducted.

Adaptations of enhanced systems and lessons learned from that revolution lend themselves for direct application to the concept of Network Centric Warfare.

Successfully adapting those advances will therefore be the enabler through which we will use NCW to leverage shared awareness and time compression to ultimately bridge the gap from Battlespace Awareness to Information Superiority. The existence of a single black boxes—a singular centralized command and control system—will likely not evolve. The realized system will ultimately consist of the collaboration of information synthesized from a series of black boxes. The establishment of a system adapted from the stock market model which combines the various functions of Electronic Communication Networks, customized “superbooths” of floor traders, and the Pacific Exchange’s Optimark™ Trading System will work to facilitate a comprehensive NCW system. This resultant system will lead to consolidation, efficiency, and consistency but requires the relinquishment of control over current proprietary systems.

Introduction

*"We are on the verge of a revolution that is just as profound as the change in the economy that came with the industrial revolution. Soon electronic networks will allow people to transcend the barriers of time and distance and take advantage of global markets and business opportunities not even imaginable today, opening up a new world of economic possibility and progress."*¹

Vice President Albert Gore, Jr.

The Information Age revolution is having a profound impact on the modern business world. One of the most profound impacts can be witnessed by the changes occurring in the United States stock market system. The creation of electronic networks have extended access to real-time financial information allowing an increased number of investors to make important decisions to quickly changing market conditions, around the clock, and independent of geographic location. These networks have leveraged technological enhancements and brought about changes in the fundamental way business is conducted in the market. Adaptations of systems and lessons learned from the revolution occurring in today's stock market model lend themselves for direct adaptation to the concept of Network Centric Warfare (NCW). Successful adaptation of the same technological advances and lessons learned will therefore be the enabler through which we use NCW to leverage shared awareness and time compression to ultimately bridge the gap from Battlespace Awareness to Information Superiority (see Figure 1). This resultant networked Command and Control system will ultimately lead to consolidation, efficiency, and consistency but requires the relinquishment of control over current proprietary systems.

Benevolence of Change

The computer has come to epitomize modern life and takes center stage in the Information Age revolution. Modern computers have vastly matured in their inherent

abilities and today do more than simply compute numbers. Supermarket scanners instantly calculate grocery bills while simultaneously controlling store inventory; computerized telephone switching matrices route millions of calls while keeping lines of communication untangled; and automated teller machines allow banking transactions to be conducted from virtually anywhere in the world. The evolution of computers, the World Wide Web, and the Internet have had a profound impact on the very essence of our way of life. As a society, we have grown dependent on their use, which has facilitated their existence to complete even the simplest of tasks in our everyday lives. Computer chips abound today in nearly every piece of electronic equipment. Our world is quickly becoming one in which our focus involves linking together these products as a means of increasing our efficiency. By bringing these items together, we have essentially created network centric systems. These systems have evolved exponentially in the business sector as a means for increased efficiency, productivity, and ultimately profitability. A perfect example of the conceptual application of network centric operations is readily evident in the revolution occurring in the United States investment banking industry. Within the stock market there exists an extremely fragmented system consisting of myriad sub-markets making up its framework.² The ongoing proliferation of Electronic Communication Networks (ECN's), proprietary trading systems, independent broker/dealers, alternative trading and routing systems such as DTNIQ and GLOBEX, powerhouse brokerage houses, and Internet trading work to perpetuate this fragmentation. The stock market has recognized the inefficiencies caused by fragmentation and is evolving through technological advances. They are attempting to decrease the fragmentation by leveraging information technology to create a centralized information system to collect, process and share real time information within all facets of the network.

The results of systemic evolution of the United States military structure are not unlike the fragmented structure and systems found in today's stock market. The Department of Defense (DOD) has similarly evolved into an extremely fragmented system through not only the creation of the individual services but also through creation of specialized branches within respective services. As in the stock market, there are an abundance of proprietary systems that exist within each service, individual warfare community, and specific weapon platform. Breaking down the barriers in this fragmented system, developed as a result of proprietary systems, and creating a network that shares information is key to creating optimal proficiency whether you are in corporate America or on the military battlefield. The stock market is working to decrease the degree of fragmentation and integrate the many facets to create shared awareness. Similarly, the DOD has come to recognize the potential leverage to be gained in combat by exploiting a superior informational position through the advantage of networked-shared awareness. Consequently, they have set the stage for the dramatic shift from a fragmented weapon or platform-centric warfare environment to a fully integrated and interoperable Network Centric Warfare (NCW) environment.

The Black Box Conundrum

"In 1975, Congress did not define exactly what a national market system should be, leaving it to competition to sort out. The electronic national book with automatic execution, or the so-called Black Box market, solution espoused by many was as vehemently opposed by others, and the SEC did not embrace it. "Congress had so much respect for competitive forces it refused to even define the national market system it called for, saying in a Senate report on the 1975 amendment"

- Steven Wunsch, president of the Arizona Stock Exchange Inc.
(AZX), Phoenix.³

Black Box—THE singular command and control point from which all aspects of operations are controlled. The development of a black box lies at the heart of Network

Centric Warfare. This concept took center stage in 1996 when former Chairman of the Joint Chiefs of Staff, General John M. Shalikashvili, published *"Joint Vision 2010"* which fomented the operational concept of joint warfighting. This conceptual template of how "America's Armed Forces will channel the vitality and innovation of our people and leverage technological opportunities to achieve new levels of effectiveness in joint warfighting"⁴ put the procurement, endowment and employment of complete networks, with their inherent ability to share near real-time information, at the core of military strategy for the upcoming decade. The establishment of network-based infostructure is therefore the essential ingredient to the foundation of a NCW environment. Vice Admiral Arthur Cebrowski, one of the Navy's strongest NCW advocates, envisions an infostructure that will include the following: an "information grid" to provide the backbone for the seamless transfer of communications and computer data; a "sensor grid" designed to ascertain the adversary's weapon systems and force positions; and an "engagement grid" which will allow for precision weapon engagement on selected targets.⁵ This complex system, comprised of multiple disparate elements, requires amalgamation in order to achieve the desired common operational picture derived from the network.

This approach is naturally driving the search for a black box—that centralized information system from which all aspects of the network will be controlled. This black box is the know-all, see-all eyes and ears of the network. Ironically, this conceptual black box does not currently exist. With regards to the stock market, the fundamental underlying traditions within that institution have led to the resultant prevailing sentiment of "The United States stock market is not ready for a single black box".⁶ Correspondingly, the United States military, traditionally resistant to change, is probably not ready for such a dramatic change

either. The service stovepipes that exist today are powerful barriers to achieving a single black box system and the services are tightly interlaced in a zero sum environment in which no one intends to lose. The realized system might consist of the collaboration of information synthesized from a series of black boxes through a centralized C4I center.

Impact of Electronic Trading

"On-line brokerage has significantly changed the dynamics of the marketplace, causing one of the biggest shifts in individual investors' relationships with their brokers since the invention of the telephone."

-Excerpt from Special Study: On-line Brokerages: Keeping Apace of Cyberspace

The National Association of Securities Dealers Automated Quotation (NASDAQ), launched in 1971, "hitched its wagon to the star of emerging computer technology in order to provide greater simplicity and efficiency to the stock marketplace."⁸ The evolution of electronic trading systems—movement from paper systems, to the phone, and now to on-line systems—have continued to proliferate in the U.S. stock market and are starting to have an affect on fundamental trading activities. "Certainly, images of the NYSE trading floor, bustling with brokers and littered with paper, are part of America's economic folklore"⁹ but the impact of technology has shaken this long-standing paradigm and has enabled investing to evolve with technological advances. The Internet has allowed individual investors access to a wealth of financial information from just about any location. Today's investors have become information enabled through access to crucial financial information that was once only accessible to institutions and market professionals. The information includes real-time news developments, market data, company fundamentals, stock evaluations and real-time quotes. Moreover, the individual investors have access to investing tools which provide the

means necessary to analyze the various reports and data. Having gathered all the information available, the individual investor is able to make decisions and act quickly to changing market conditions through the services provided by on-line brokerages. The mechanics of executing a trade have not necessarily changed but the “tectonic shift of influence away from institutions and toward individuals is expressed in numerous venues.”¹⁰ For example, Initial Public Offerings (IPOs) are no longer exclusive to investment bankers, conference calls are typically conducted via webcasts that are available to the general public, and commodity and foreign currency exchanges—once institution only markets—are now available to individuals.¹¹

Electronic trading has effectively brought an incalculable number of computers and investors to the network. Evidence the fact that online accounts have nearly tripled in the last two years.¹² As more and more investors connect to the network, they unite to increase its potential value. Metcalfe’s Law (see Figure 2) states—as the number of nodes in a network increases linearly, the potential “value” or “effectiveness” of the network increases exponentially as the square number of nodes in the network—which illustrates the potential value of this network. Similarly, the concept of NCW, which calls for the creation of such a network, would likely emulate the system in existence in the stock market today. The objective of the network would be to create shared awareness throughout and may ultimately allow for a state of ubiquity with regards to the conduct of military operations.

The impact of electronic trading technology is transforming the securities market and possesses lessons for direct military application to NCW concepts. These technologies are proving to be cost-effective by lowering start-up costs for new systems and substantially reducing continuing operating costs. This is readily evident in the proliferation of upstart

trading companies around the world utilizing alternative trading systems and the quick installation of similar systems by the likes of traditional powerhouse brokers such as Charles Schwab, Fidelity, and Morgan Stanley Dean Witter. This new technology is altering the dynamics of the marketplace because it removes physical constraints such as geography, time, and distance while simultaneously increasing the number of market participants. It also has the tremendous potential to disintermediate—remove the middleman—from the markets by allowing buyers and sellers to be matched up without the use of a market intermediary effectively mirroring the anticipated ability of NCW to link sensor and shooter.¹³ All of the technological impact occurring in the market today as a result of these new systems possesses relevancy to the military of tomorrow that is able to leverage similar technologies to make NCW a reality.

The impact of Internet Technology on the stock market has improved communications while streamlining transaction activities. Electronic trading systems have significantly improved accuracy, productivity, as well as the speed of execution and made the delivery of critical market information nothing short of instantaneous. The methods of trading, however, have leveraged information technology to provide investors with greater access and ultimately efficiency.

Internet Technology Leads to Efficiency

"Alternative stock exchanges, operating as computerized, database-driven order-matching systems, are grabbing trading volume at a rate that cannot fail to alarm the established exchanges. Offering greater efficiency, better prices and expanded trading hours, these electronic communications networks, or ECNs, have rattled the status quo, motivating the NYSE and NASDAQ to plan extensions for their trading days."¹⁴

-Brad Hill, Investor 2000

Nearly every demand an investor wants in order to make an informed decision can be found on the Internet today. Information is available any time, around the clock, and may be accessed from the convenience of home, office, nearest cybercafe, and now from your personal digital phone or palm sized personal digital assistant. Nearly 96 million people in the U.S. currently have access to the Internet and at least one survey has estimated that 54 percent of American homes have a personal computer.¹⁵ Dataquest, a leading IT market research and consulting firm for suppliers of information technology and the financial and investment communities, estimated that 82 million personal computers were connected to the Internet in 1997 and those numbers would increase to 268 million by the year 2001.¹⁶ There are hosts of reasons for the overwhelming increase of people accessing the net, the most noteworthy of which is their ability to become more efficient through access to information. The financial world is internally leveraging technology to increase profits by sharing information within all facets of the stock market model. One method has been the use of Intranets as a means to breakdown information into diversified categories effecting a smoother and more timely informational transfer. These Intranets have allowed better integration of data across the entire network and thus increased efficiency. All of these improvements have led to gains that have corollary functions within a NCW network. Take for example, the following benefits gained in a stock market that leverages this technology as they apply to respective gains of NCW Decisive Operations:

- Shared knowledge and information leads to simplified execution of trade orders which equates to Speed of Command in the battlespace
- Error reduction in order processing equates to accurate Focused Logistics

- Increased productivity because of enhanced access to information equates to Increased Combat Power
- Real-time access to information equates to Increased Tempo of Operations
- Platform independence through which proprietary systems are married by technology equates to Greater Lethality and Increased Survivability when proprietary platforms and weapon systems become interoperable

All of the benefits derived by creating networks in the stock market model have application to the military operations, especially a Network Centric Warfare enabled military.

Adaptations from the Stock Market

Infostructure is the foundation to automating both the stock market and the establishment of Network Centric Warfare. The stock market has begun to leverage technology to its advantage and is developing the means to solve the black box conundrum. By adapting the same Internet Technology systems automating today's stock market, we will provide the means to expedite the evolution of the NCW concepts.

Electronic Communication Networks have produced electronic meeting places for institutions and brokerages to display and match stock orders. Currently, there are a number of proprietary systems in the market model that act independently from one another by only matching up clients within their respective system. There are ongoing efforts to create a centralized system that would allow all the proprietary systems to link together in one central market allowing the number of match ups to increase exponentially. Bringing these services together increases market liquidity and expands the market for investors by giving them access to multiple systems. Establishing a system similar to this, which allows for

centralized transfer of information, is pivotal for the successful application of NCW operations. This infostructural foundation is evolving in today's marketplace and successful adaptation of these systems to military operations will provide the starting point for networking forces on the battlefield.

Another system that exists in today's stock market can be found in the high-tech, customized superbooth. Companies are putting the technological luxuries of upstairs offices on the market floor. These high-tech equipped booths—90 square foot kiosks—are replacing the 18-inch wide wooden stations currently occupied by today's floor specialists. Solomon Smith Barney (SSB) has created the Booth Management System which “displays the status of pending orders at each of the SSB's seven locations on the exchange floor, forming a kind of command control center.”¹⁷ Moreover, the use of handheld devices for seamless transfer of stock orders is over taking the notepads of yesteryear. The days of wading through ankle deep paper to execute orders is quickly coming to an end. Previously, in the comfort of their upstairs offices, high above the trading floor, these firms enjoyed the effects of leveraging technology to gain Information Superiority. Today, they are transferring those same technologies to the floor thus expounding on that informational advantage. In doing so, they now possess “ubiquitous communications pulling in research, pricing data, market news, client and other information across databases, with sophisticated analysis programs at their fingertips; FIX protocol-based interfaces for accessing clients, broker/dealers and custodians; seamless links to electronic communication networks (ECNs), alternative trading and routing systems, and the Internet—all affording them the highest, customized efficiencies and the ability to act independently worldwide.”¹⁸ The advantages these superbooths give to the network mirrors the epitome of C4I systems desired in a NCW environment. They provide a

compact, centralized center for real-time informational control, analysis and dissemination. These networked superbooths are proving to be the way of the future for stock market operations and bringing them one step closer to complete automation of the marketplace. Successful adaptation of the existing hardware and software systems will prove complementary in its use of military applications and the establishment of NCW operations.

The Pacific Exchange, the world's third most active options exchange, took another step towards solving the black box conundrum by implementing the OptiMark™ Trading System—the “central information processing system and related administrative and communications terminal network that collects and processes data, log activities, and switch messages from and to other systems and carriers, as well as communication network linking such computers with customer terminals.”¹⁹ This supercomputer-driven system provides automatic order formulation, matching, and execution capabilities in the securities listed or traded on the Exchange.

Professionals, in the Pacific Exchange, have commented that the Optimark™ System is the type of development of the national market system (NMS) envisioned in the Securities Acts Amendment of 1975. This is precisely the black box concept representative of “the kind of new ‘data processing and communications techniques’”²⁰ that Congress wanted when it passed the 1975 Amendment. Additionally, as one professional remarked, this type of system creates “the opportunity for more efficient and effective market operations, and [will] foster efficiency, enhance competition, facilitate the offsetting of customer orders, and contribute to best execution.”²¹

The military implications of such a comprehensive system for the establishment of NCW concepts are exhilarating. Even the daunting requirements of the United States

Securities and Exchange Commission could not hinder the acceptance and installation of this system. It fundamentally establishes the core essence of network centrality by establishing the heart of network—a centralized Command and Control center or black box. This type of system exhibits all the characteristics desired in military systems by having met the stringent requirements for establishment in the NMS. It is functional, interoperable, efficient, and secure.

Another application from the stock market revolution resides in lessons learned from the shift to extended hours trading with eventual around the clock trading of securities. Frank Zarb, Chairman and CEO of U.S. National Association of Securities Dealers, envisions the stock market of the future globally trading securities on a completely digital market that is accessible 24 hours a day, seven days a week. Investors will obtain real time information, execute instant trades around the clock, anywhere on the globe and the stock markets will be linked, interoperable and nearly all electronic.²² The lessons derived from this transformation appeal for military application and lend itself directly to the concept of around the clock warfighting. As the markets make this shift, it will be interesting to see how they deal with the greatest military challenge we face today—manpower. The military has identified this as a shortfall and should pay close attention to the unfolding of this 24-hour, seven day a week forum of trading that will yield valuable lessons for the military adaptation in creating the existence of around the clock NCW systems.

The Navy is currently investing money and research into developing similar systems designed to accomplish networked operations. For example, the WeCAN (Web-Centric ASW Network) system is designed to provide an ASW Common Tactical Picture through near real-time information sharing and collaborative planning by using common

links and interfaces for data retrieval and reporting. This system enables robust information sharing (self-synchronization), enhanced situational awareness, automation for alertment, archiving ability of information, and enhanced communications. The enhanced Information Superiority gained through the Network Centric Application provides improved warfighting capability to the fleet.²³ This type of first generation network centric system yields tremendous increased potential through the incorporation of the same technological enhancements found in the stock market systems today.

Challenges

So what are the challenges to implementing these proven systems to the application of NCW models? As with all revolutions, there are advances to be gained but they always come with some kind of cost. Network Centric Warfare will face challenges spanning the spectrum from academic to technical as it evolves. Everyone is best served by meeting these new challenges as if they were opportunities and not liabilities.

The most obvious challenge to this concept is that it is based on new technologies, some of which have not even been created or designed yet. This has led many to argue that there is an over reliance on technology in implementing such a concept. This mindset would easily apply to just about every successful business venture initiated past, present and future. Without vision, you effectively inhibit innovative thinking and exclude promising new ideas before they afforded the opportunity to be developed. This vision advances creative manipulation of existing technologies to now meet previously unrelated aspects of the NCW concept. Technology alone does not ensure success but being first to leverage that

technology will inevitably gain an advantage in battle. "Nobody can survive without sophisticated technology, but it's like a nuclear arms race. Everybody catches up."²⁴

Assuming that innovation leads to new systems, which enhance the concept, the reliance on technology creates dependency and vulnerabilities that are susceptible to Information Warfare (IW). The availability and low cost of existing commercial technologies greatly increases the probability that a future adversary will employ those systems against us in future conflicts. "However, the same technologies also create vulnerabilities for our adversaries that can be exploited using offensive IW capabilities."²⁵ IW is a double-edged sword as it creates as many new capabilities as it does vulnerabilities. Our vulnerabilities will be countered by leveraging information superiority that is enabled through network centric operations. This technological advantage will enable us to not only control the flow of information within our own systems but also to affect the adversary's ability to control theirs. As long as we recognize our own vulnerability, successfully developing IW capabilities will "ensure warfighters have the tools to exploit adversary vulnerabilities while ensuring full access to timely, accurate, and relevant information wherever and whenever needed."²⁶

The greatest challenge faced in implementing a centralized "superbooth" for the military lies in the inherent evolution of disintermediation—or cutting out the middleman. Having created a networked information environment where everyone on the network has the same information and common operational picture, the natural tendency would encourage centralized execution effectively cutting out the middleman. This is readily evident in the stock market revolution by the advent of alternative stock exchanges which have put

investors in direct communication with one another matching buy and sell orders.

Networking "has two overriding effects on the financial markets:

- **Decentralization.** The liberation of information and access to markets has splintered the ties between investors and traditional Wall Street power centers. Competition provides alternatives, and consumers are choosing those alternatives in increasing numbers.
- **Disintermediation.** Networking technology eliminates the middleman. In the old days, placing an order for a NYSE stock initiated a domino-like chain of events and individuals, including the customer's broker, a trading desk, a sales trader, a position trader, a floor trader, and a floor specialist. New alternative stock exchanges proceed far more directly from buyer to seller, saving money and time along the way."²⁷

These possibilities have the potential to exist in the military as the NCW concept is implemented. The antithesis to this resides in the coevolution of policy simultaneously with conceptual development. We are uniquely positioned to create advantages learned from the market revolution. We can capitalize on the capabilities of shared awareness and actually push the information down the chain of command. Decision-making can be accomplished at lower levels because everyone shares the same operational picture. Moreover, it is in our best interest to keep the middlemen in our process because they provide the trusted relationship, intellectual in nature, between the decision-makers and the warfighters. They also work to increase the efficiency of the warfighters as well as possess the ability to shorten the length of time necessary for specific courses of action. Although it may be advantageous in the business world to cut out the middleman in order to save money, in the military they

provide the crucial human link between the top and bottom of the chain ensuring efficiency and compliance by the human vice monetary dimension.

Cultural Transformation

*"History supports the view that valuable insights have relevance across disparate domains. A fundamental lesson that has emerged from multiple domains, including business and warfare, is that the power of a new technology cannot be fully exploited to create competitive advantage without the simultaneous coevolution of organization and process."*²⁸

-Excerpt from Network Centric Warfare: Information Age Organizations

Without question, the Internet has sparked a revolution with respect to the increased access to information. Today, people that are connected to the Internet have access to more information in a couple days than their grandparents were exposed to in their entire lifetime. This information-enabled revolution is occurring in corporate America at an unprecedented rate. Information has become a commodity and "(h)istorically, any institution that gets in the way of access to information eventually topples."²⁹ NCW is the military's enabler of increased access to information. Revolutions of this magnitude, however, are in effect a double-edged sword as they "elicit regret for what has been lost, mingled with triumph at what has been gained." The revolution occurring in today's stock market is working to break down the traditional monolithic systems and replace them with smaller, more responsive, and more competitive systems.³⁰ The break down of this successful business infrastructure is having a profound impact on the business world requiring a shift in paradigms. For example, the shift has led to the creation of virtual organizations in which companies reorganize and ally themselves with others to form virtual, interconnected organizations such as MySimon.com and BiddersEdge.com. The success of these virtual organizations is dependent upon a successful shift to network computing. Networked computers now

perform complex tasks aided by access to other users, programs and information through the network. This paradigm shift has led to new programming standards, platform neutrality, and increased network engagement. The success of this paradigm shift and efficiency of information sharing is dependent upon user ability to adapt the change.

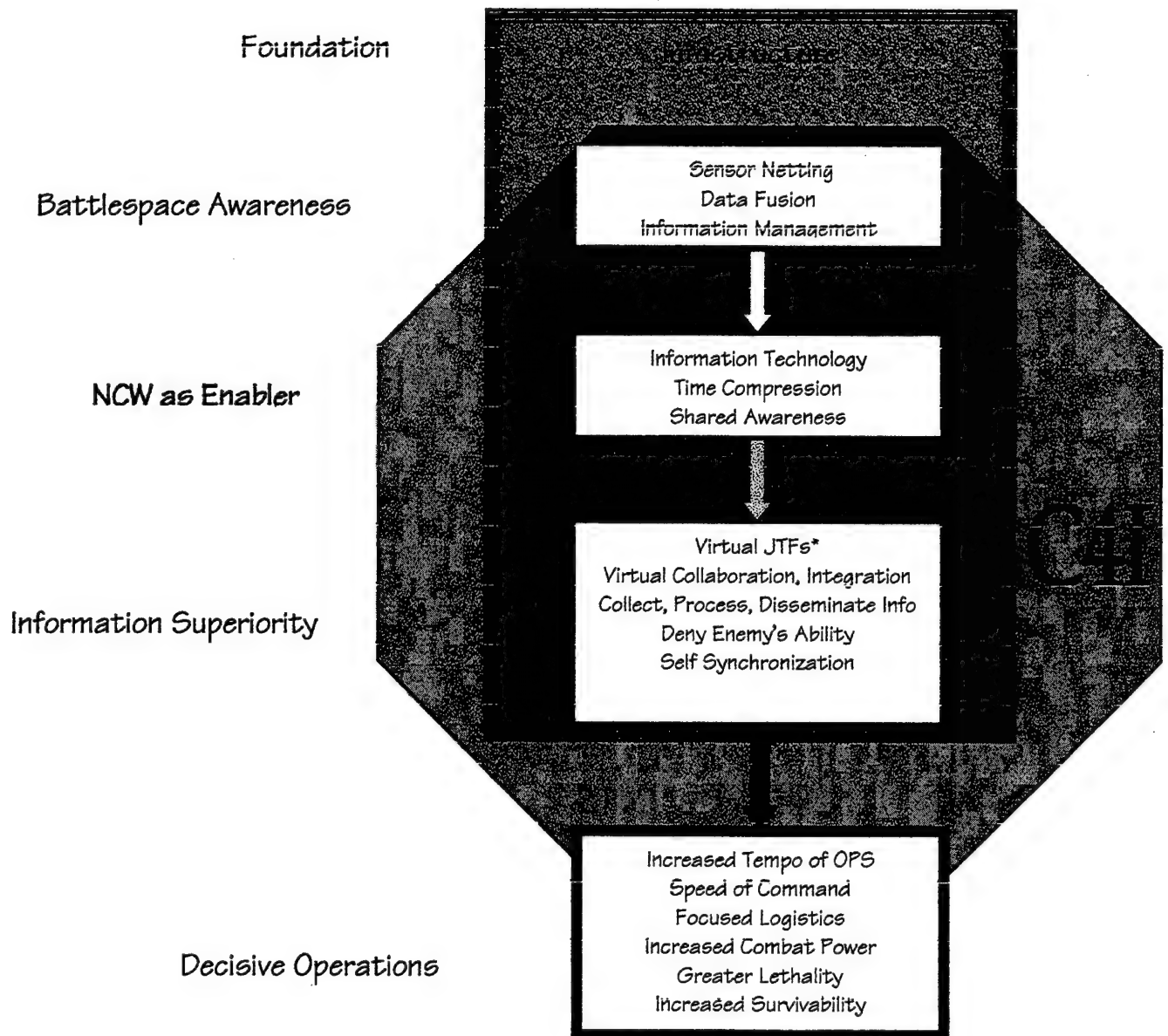
Long-standing traditions and culture comparable to the traditions and culture of stock market floor traders bind our military conduct. Fully automated electronic trading systems have altered the marketplace just as the concept of NCW will alter military traditions. Access to information is shaping the stock market of tomorrow and "technology is the enabler to make all this happen, but it is information that is the driver."³¹ There are similar effects found in both environments. Automation of the market can be translated to Self-Synchronization of forces in the battlespace. Complete automation of the market leads to around the clock trading as systems work to match up buyers and sellers within the network. All of the information required to complete the match resides in the network and technology provides the means to bring the two together. Similarly, in a NCW environment, all of the required information for synchronous action between two units will reside in the network and giving the units access to that information will allow them to operate in concert with one another without interference. The basis for this execution requires common operating systems and architecture allowing for interoperability. The stock market system effectively does that today because it is able to process information from various sources within the network and share that information real-time allowing trades to occur instantaneously. None of these changes can occur without fundamental organizational modification and alteration of traditional service paradigms.

Conclusion

The transformation from traditional military culture and organization to network centric operations is a tremendous challenge. The revolution occurring in the stock market provides numerous applications to more rapidly facilitate the evolution of the NCW concept. The establishment of network centric systems in the financial world has given individual investors access to a wide array of new tools. Moreover, the stock market's ability to create a system comprised of completely interoperable, real-time networks, interfaced at a central location, is a testament to gaining advantage by leveraging technological enhancements for ones own benefit. The most profound advantage it has given to the individual investor is in the tools now available to plan. Having access to these valuable resources and implementing them to achieve your plan has profound corollary military application. The establishment of these networked systems and military adaptation in the creation of similar C4I centers will prove easier because of those efforts. Just as the system will allow an investor the tools required to proficiently plan the steps to achieve financial goals, it will provide the military with the necessary tools to plan and achieve military goals. The real time informational sharing within the multi-faceted Command and Control network will be the vehicle to attaining Competitive Advantage in a Network Centric Campaign. The real time sharing of information will provide decision-makers with a common operational picture that will facilitate self-synchronization as well as increase the tempo and responsiveness of operations.³² By leveraging lessons derived from the stock market model and the same technological enhancements, the military can create an improved centralized information Command, Control, Communications, Computers and Intelligence (C4I) Center. This new

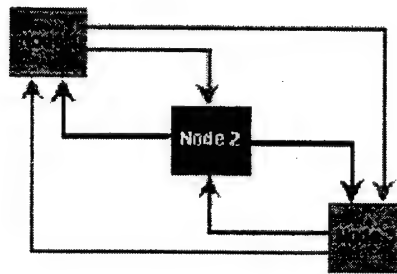
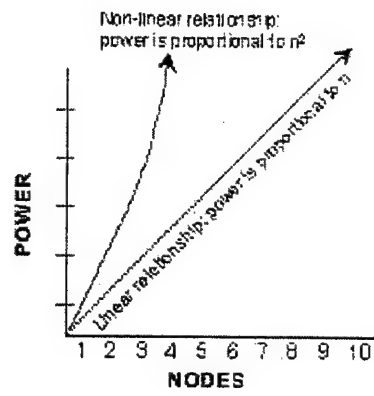
system will give the warfighters of today a competitive advantage on the battlefield of tomorrow.

Figure 1
The Network Centric Campaign



*Virtual JTFs bring the necessary people and processes together to accomplish a campaign. When the campaign is over, those resources may be utilized for other tasks. Virtual JTFs, enabled by networking, allow services to leverage the advantages gained by Information Superiority that are associated with virtual collaboration, virtual integration and outsourcing.³³

Figure 2
Metcalf's Law³⁴



¹ President and Vice President, A Framework For Global Electronic Commerce, (Washington: 1997), 1.

² Marie D'Aguanno Ito, Senior Counsel, Division of Market Regulation, SEC, telephone conversation with author, 30 November 1999.

³ Peter J. Brennan, "Regional Stock Exchanges: Fighting The Competition", <http://www.wstonline.com/mfwt/parse.html?page=showarticle&ald=2275>, (29 November 1999), 2.

⁴ Office of the Chairman, Joint Chiefs of Staff, Joint Vision 2010, (Washington: n.d.), 1.

⁵ David S. Alberts and others, Network Centric Warfare: Developing and Leveraging Information Superiority, (Washington: CCRP publication series, 1999), 34-36.

⁶ Marie D'Aguanno Ito, Senior Counsel, Division of Market Regulation, SEC, telephone conversation with author, 30 November 1999.

⁷ "On-Line Brokerage: Keeping Apace of Cyberspace", Special Study Executive Summary: On-Line Brokerage, <http://www.sec.gov/news/studies/cybexsum.htm>, (30 November 1999), 1.

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